

Research Article

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Investigating access and use of digital tools for agriculture among rural farmers: A case study of Nkomazi Municipality, South Africa

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Abstract: The study examined the access and utilization of digital tools for agriculture among rural farmers in Nkomazi, Mpumalanga, South Africa. Data were collected from 120 rural farmers who were purposively sampled in Nkomazi Municipality. Information was gathered from the respondents through enumerator-administered structured questionnaires. The data were analyzed descriptively using percentages, means, and ranks, and multiple linear regression was employed to analyze the influence of the farmers' socio-economic characteristics on their utilization of digital tools. The findings reveal that the farmers had an average age of 45.81 years. Approximately half (50.9%) of the farmers had no formal education or only completed primary education, and the average years of farming experience was 8.62 years. Overall, the farmers had access to traditional digital tools and apps such as radio, television, and smartphones. However, their utilization of these tools and apps, especially modern digital tools such as WhatsApp (43.3%) and Facebook (37.5%) for agricultural purposes, was still relatively low. This can be attributed to various challenges highlighted by the farmers, including insufficient skills and training, high costs of tools and apps, and issues related to network coverage. The educational level and cosmopolitanism of the farmers were identified as key socio-economic factors influencing the utilization of digital tools among the respondents. It is recommended that the farmers receive education and training on the use of modern digital tools and apps to enhance their ability to leverage them effectively and efficiently for the benefit of their agricultural enterprise.

Keywords: accessibility, challenges, digital technologies, rural farmers, utilization, South Africa

1 Introduction

Digital tools and apps are globally gaining increased usage as tools for agricultural knowledge and information brokerage [1]. The increase in the production and use of digital tools for information and communication provides a great opportunity for transforming smallholder agriculture and rural advisory services [2]. Information and communication technologies have been seen to be taking over almost all sectors including agriculture [3]. Digital technologies and apps offer new opportunities to farmers, extension organizations, policymakers, and administrators. According to Xie et al. [4], the utilization of digital tools in agriculture helps to reduce crop loss, decrease herd death, increase yields, improve cost-effectiveness in production, create safety nets, increase storage, prevent spoilage, and increase income. Furthermore, the use of digital technologies also helps to improve on-farm decision-making [5]. ICT tools enable farmers to overcome barriers that prevent them from producing sustainably and accessing bigger markets [6]. These tools have the power to transform agri-food systems in emerging markets by accelerating the work of participants across the agricultural value chain, including input players, producers, off-takers, and retailers [7]. According to Vasisht et al. [8], digitally driven agriculture strategies enhance agricultural productivity by increasing yields, reducing losses, and cutting down input costs. A lot of digitized technologies are used to apply elements such as fertilizers, chemicals, and water through irrigation more efficiently. Also, digitally enabled devices are used by animal farms to track the whereabouts of grazing animals and keep appropriate records. Furthermore, digital tools and apps are becoming important platforms for agricultural information access, sharing, and agricultural marketing [9].

Despite the available potentials the use of digital tools and apps has to offer, a lot of farmers, especially in rural

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areas, seem not to be fully leveraging the potentials derivable from their use. This is partly because many smallholder farmers in developing countries have limited access to advanced technologies and digital tools, resulting in these farmers experiencing low farm efficiency and food insecurity [10]. According to Suchiradipta and Saravanan [11], lack of skills, infrastructure, illiteracy, psychological barriers, and skepticism are also major inhibitors to low digital tool usage among smallholder farmers in rural regions. Furthermore, Coggins *et al.* [1] pointed out that commonly constraining factors affecting the optimal use of digital tools by farmers in Africa and Asia include devices and infrastructure inaccessibility, digital illiteracy, and issues relating to interpretations and appropriateness of information obtained through these platforms. However, as pointed out by Aguera *et al.* [12], the lagging behind of smallholder farmers in rural areas of African countries (including South Africa) will further reduce their ability to scale up production and compete favorably in the agricultural space. It is therefore very pertinent for agricultural stakeholders to ensure that smallholder farmers are well supported to adapt and keep up with the digital revolution for the achievement of sustainable agricultural production and development. According to Accenture [13], the intensification of digital agri-technologies usage among farmers can facilitate great value for South Africa between now and 2026.

Hence, it is important to assess the level of access and use of digital tools among rural farmers in South Africa to generate current empirical information that has not been available in the study area previously. This information will be useful to strategize and improve digital tools usage among smallholder rural farmers in the country. Thus, this study aims to evaluate digital tool usage among smallholder rural farmers using Nkomazi Municipality, South Africa, as a case study. Specifically, the study ascertains the digital tools that the smallholder farmers have access to, determines the tools used by the farmers, identifies the challenges faced by the farmers in relation to their utilization of digital tools for agricultural purposes in the area, and also investigates the socio-economic factors influencing the digital tools usage among the rural farmers.

2 Literature review and conceptual framework

Globally, digital agriculture has been revolutionizing the agriculture sector by providing solutions to farmers' information

needs and facilitating interaction among various stakeholders in the agri-food sector [14]. However, the concept of digital agriculture, which involves access to and use of digital tools, is still new among smallholder farmers in many parts of the world, particularly in the global south. There are, however, a few early adopters who have access to and use some of these tools for agricultural information, networking, and marketing. According to Gumbi *et al.* [15], digital agriculture has the potential to address the specific needs of smallholder farmers in rural areas of Africa. Krone *et al.* [16] also noted that increased use of ICT and digital tools can greatly improve smallholder farming by enhancing knowledge access and developing business linkages. Furthermore, Baumüller [17] highlighted that smallholder farmers in developing countries who use digital applications on mobile phones have benefited in terms of production planning, weather-related risk management, and financial transactions. Despite the evident and potential benefits of digital tools for smallholder farmers in the global south, there are several factors, as mentioned in the literature, that hinder their access and optimal use of these tools for sustainable agricultural production and livelihoods. Misaki *et al.* [18] stated that smallholder farmers face various challenges, such as lack of access to smartphones, internet infrastructure, and digital knowledge, which prevent them from fully utilizing mobile phones and digital technologies. Additionally, Okello *et al.* [19] indicated that the use of digital tools and mobile phone technologies among smallholder farmers in Kenya is influenced by socio-economic factors such as age, gender, transportation costs, literacy level, crop income, asset value, household size, and ownership of mobile phones. These studies collectively demonstrate the potential of digital tools in smallholder farming but also highlight the need to address the challenges related to access and use.

Based on a synthesis of reviewed literature, a framework (Figure 1) was developed to illustrate the interactions between variables measured in the study and how these interrelationships influence the utilization of digital tools by smallholder rural farmers in their agricultural practices. The framework includes both traditional digital broadcast tools, such as digital radio and television, and modern digital tools, such as smartphones and some installable apps, to assess the level of transition among rural farmers in terms of tool usage. The framework shows how the socio-economic profile of rural farmers, including age, educational level, enterprise type, farming experience, farm size, and exposure, can directly influence their utilization of these digital tools. Furthermore, the farmers' access to digital tools, along with the challenges they face in accessing and using these tools, all interact with their socio-economic profile and are expected to influence their utilization of

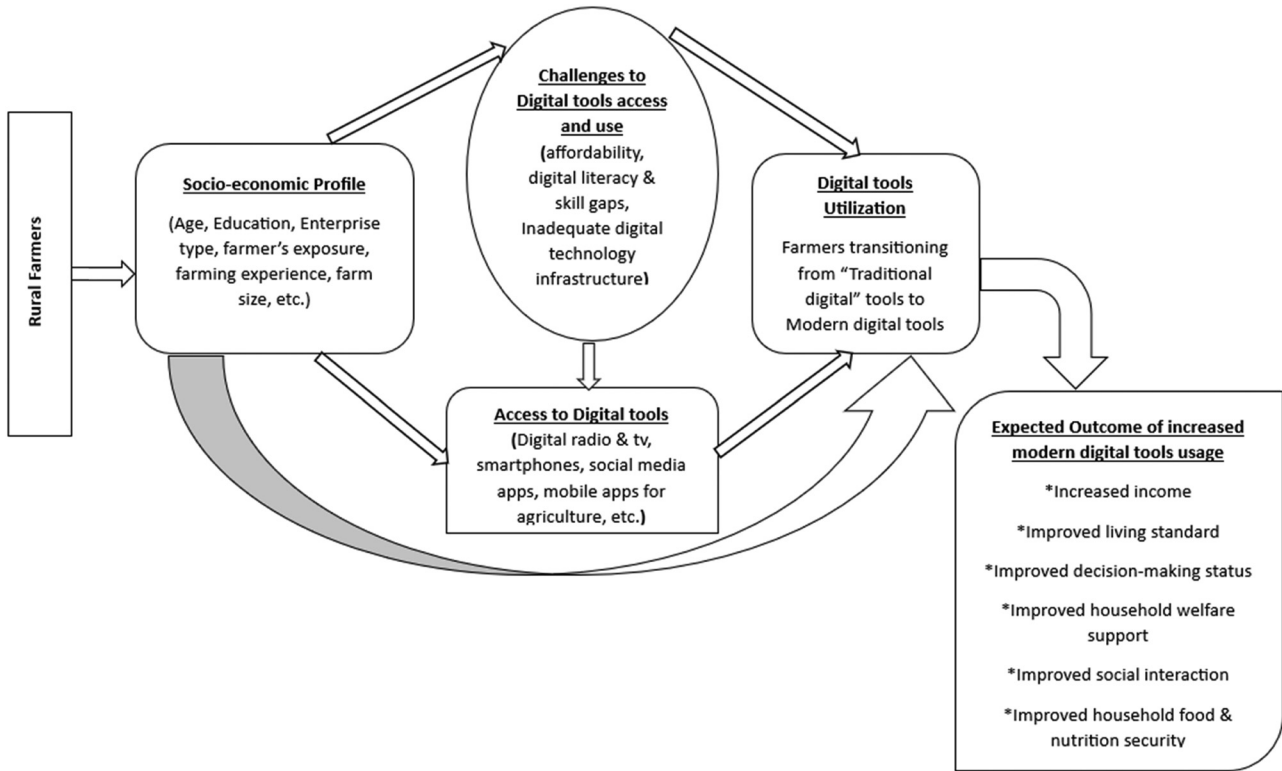


Figure 1: Conceptual framework for digital tools access and utilization (conceived from a synthesis of reviewed models and literature). Source: Author's Concept.

these digital tools. Ultimately, increased utilization of modern digital tools by rural farmers in their farming enterprises is expected to result in improved information access, marketing and income, decision-making, networking, and social interaction among farmers and other agricultural stakeholders, contributing to sustainable food security and livelihoods.

3 Materials and methods

The study was carried out in Nkomazi Municipality, Mpumalanga, South Africa. Nkomazi is located in the Ehlanzeni District, which is located northeast of the Mpumalanga Province, South Africa. As shown in Figure 2, it is one of the four municipalities in the district. The Nkomazi Municipality covers approximately 4,787 km², with most of the population residing in rural areas, and this made it a good case study for this research when compared to the rural–urban population in other municipalities in the province. The municipality's industrial sector is dominated by agriculture, as most of the rural dwellers are smallholder farmers [20]. The municipality is located at 25.7097° S, 31.7195° E. It has a subtropical climate with an average annual temperature of 28°C and an average annual rainfall of 775 mm [20].

The study carried out a quantitative research approach and cross-sectional survey research design to assess the access to and use of digital tools among the respondents. The population of the study included all registered smallholder rural farmers residing in Nkomazi Municipality. According to the extension agent contacted at the Department of Agriculture, Rural Development, Land, and Environmental Affairs (DARDLEA), the number of registered farmers at that time was 2,563. A list containing the contact details of these registered farmers was then obtained and served as the sampling frame for the study participants' selection. Using the Raosoft sample size calculator at a 95% confidence level and a 5% margin of error, the number of farmers required to be sampled for the study is 335 [21]. However, due to constraints faced related to time and farmers' willingness to participate during the data collection process, especially because the study was conducted during the transition period from the COVID-19 pandemic in 2021, only 120 farmers were purposively selected from the sample frame across the municipality. Purposive selection of respondents considered key inclusion criteria such as age, gender, and enterprise type of available farmers to ensure representation from different demographic groups within the available sampling frame. Informed consent was sought from all farmers who



Figure 2: Map of Ehlanzeni District showing the study area (Nkomazi Municipality). Source: <https://municipalities.co.za/map/1144/nkomazi-local-municipality>.

participated in the study, and participation was voluntary. Information was elicited by the researcher and trained enumerators from the sampled respondents using a structured questionnaire, and data collection in the study was carried out in accordance with all health protocols and relevant ethical principles as stipulated by the Declaration of Helsinki. The survey instrument was composed of sections focused on specific study objectives. Eliciting data on access to digital tools: A list of 11 digital tools and apps was presented to the farmers, and they were asked to indicate whether they have access to these digital tools or not, rated as Have access (1) and do not have access (0). Data on the challenges to digital tools usage for agriculture among the farmers was rated on a 3-point severity scale of very severe (2), moderately severe (1), and not severe (0).

Data on utilization of digital tools: The farmers were presented with 11 digital tools and apps (made up of 2 traditional inclined digital broadcast media tools and 9 modern digital tools) and were asked to indicate whether they use (1) or do not use (0) these tools. Following the precedence of Abegunde *et al.* [22], a composite score analysis was then used to generate a digital use score for each

respondent with a maximum attainable score of 11 and a minimum score of 0. The higher the score obtained by farmers indicates their level of use of digital tools, which also indicates their extent of transition from the use of traditional digital tools to modern digital tools. This generated score served as a proxy to represent the digital use score for each respondent, which was then fitted as a dependent variable in the multiple linear regression model used to determine the socio-economic factors influencing respondents' digital tool utilization. The collected data were analyzed descriptively and presented in tabular format using frequency, percentages, means, and ranks. Additionally, a multiple linear regression model was used as an inferential statistic to determine the influence of the socio-economic attributes of the farmers on their use of digital tools.

The explicit form of the model can thus be given as

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 \dots B_n X_n + \mu,$$

where Y is the farmer's digital use score; X is a vector of hypothesized explanatory variables, which included farmers' socio-economic characteristics (marital status, household size, gender, farm size, educational level, farming experience,

extension visit, and so on); β is a vector of parameters to be estimated by the model; and μ is the random error term.

Consent: Informed consent was sought from all farmers who participated in the study and participation was voluntary.

4 Results

4.1 Socio-economic characteristics of the farmers

Table 1 shows that about two-thirds (65.0%) of the respondents in the area were females, indicating the prominence of female involvement in agriculture, especially in the rural areas. This is in consonance with Sambo et al. [23], who reported a high level of female participation in agricultural activities in the area. About two-thirds (60.0%) of

the respondents were 41 years and above, while only a few (5.9%) were 20 years and below. The mean age of the respondents was 45.81 years and had a standard deviation of 14.16. This shows that most of the farmers are still in their active and productive years and thus should be open to the use of digital tools to improve their economic activities. Although most of the farmers in that area are still economically active, most of them are in their middle ages, and there is a need to incentivize more youth to venture into agricultural-related enterprises in the area.

Furthermore, the majority (70%) of the respondents indicated that they are unmarried. As opined by Newlin [24], this might be due to the high rate of divorce and single parenting in South Africa. However, the high unmarried rate does not imply fewer family responsibilities or a smaller household size, as the mean household size in the area is five persons with a standard deviation of 2. The implication of this is that the farmers will need to provide for many people, which may constrain their financial resources and reduce their digital access and use prowess. A little below half (49.1%) of the farmers had secondary education and above. It can be deduced that many of the respondents still have no or low level of formal education. This attribute has the tendency to influence the innovativeness of the farmers and thus their level of use of digital tools and apps. According to Mabohlo et al. [25], a higher level of formal education attainment enhances the usage of ICT and digital tools.

Moreover, the majority (74.2%) of the respondents indicated that they had between 1 and 10 years of agricultural production experience, while only a very few (1.6%) had 31–40 years of experience. The mean years of farming experience was 8.62 years. The assumption is that, on average, the farmers in the area have some substantial experience in agriculture, which might also positively influence their level of use of digital tools. As stated by Sebeho [26], an increase in the level of farming experience positively influences farmers' innovativeness and decision-making skills. The majority (93.3%) of the respondents had no secondary occupation. This result suggests that agriculture is their main source of income, and thus, they are expected to give it their all and be ready to leverage innovative opportunities that can enhance their productivity, such as the use of digital tools and apps that have the potential to offer.

4.2 Farm-related characteristics of the farmers

The findings in Table 2 reveal that a great majority (90%) of the farms deal with crop production, and only a very few

Table 1: Rural farmers' socio-economic characteristics

Variables	Frequency	Percentage	Mean
Gender			
Male	42	35.0	
Female	78	65.0	
Age			
≤20	7	5.9	
21–40	41	34.2	45.81
41–60	51	42.5	
61 and above	21	17.5	
Marital status			
Unmarried	84	70.0	
Married	36	30.0	
Household size			
1–5	91	75.9	5
6–10	26	21.7	
11–15	3	2.4	
Educational level			
No formal education	32	26.7	
Primary	29	24.2	
Secondary	54	45.0	
ABET	3	2.5	
Tertiary	2	1.7	
Years of experience			
1–10	89	74.2	
11–20	23	19.3	8.62
21–30	6	5.1	
31–40	2	1.6	
Secondary employment			
None	112	93.3	
Government	5	4.2	
Private	1	0.8	
Self-employed	2	1.7	

Source: Field Survey, 2021. $N = 120$.

Table 2: Distribution of the farmers based on their farm-related characteristics

Variables	Frequency	Percentage	Mean
Enterprise type			
Crop	108	90.0	
Live-Stock	3	2.5	
Both	9	7.5	
Farm size in hectares			
<1	31	25.5	1.9
1–5.9	86	71.4	
6–10.9	2	1.7	
11 and above	1	0.8	
Farmer group			
No membership	60	50.0	
Have membership	60	50.0	
Extension agent visits			
No visits	34	28.3	
Yes	86	71.7	
Visits to other locations and farms			
Not at all	8	6.7	
Weekly	42	35.0	
Monthly	50	41.7	
Twice a year	18	15.0	
Yearly	2	1.7	

Source: Field Survey, 2021. $N = 120$.

(2.5%) are into livestock production, with about 7.5% of the respondents involved in both livestock and crop production. By implication, crop production is the most prominent source of livelihood among rural dwellers in the study area. Also, Table 2 indicates that a large percentage (71.4%) of the farmers have land ranging from 1 to 5.9 ha, with only a handful (0.8%) having a plot that ranges from 21 to 30.9 ha. The mean farm size is 1.9, which indicates that most of the farmers are still operating on a small-scale basis and thus have small output. According to Anigbogu *et al.* [27], smaller farm sizes result in smaller outputs and, inevitably, reduced income. Therefore, strategies that encourage and provide support for emerging farmers to increase their scale of land ownership and production are needed in the area.

Half (50%) of the respondents are members of agricultural organizations, while the other 50% are not, according to Jack *et al.* [28]. Membership in farmer groups positively influences the adoption and use of technologies in agriculture. The majority (71.7%) of the respondents have indicated that they receive frequent visits from agricultural extension agents. This implies that most of the farmers are likely to be exposed to information that could motivate them to leverage the use of digital tools for agricultural purposes. The majority (76.7%) of the farmers also indicated that they

regularly visited other locations and farms. This attribute also increases the level of exposure of these farmers, which may increase their level of innovativeness and potential use of digital tools.

4.3 Access of rural farmers to digital tools

The results in Table 3 reveal that many farmers in the area indicated that they had access to television (88.3%), radio (86.7%), and smartphones (60.0%). This implies that most of the farmers in the area have access to what can be considered “traditional digital” broadcast media tools. However, even though about two-thirds (60.0%) of the farmers indicated they have access to smartphones, less than half of the respondents accessed modern digital tools and apps that can be used on these phones, such as WhatsApp (42.5%), Facebook (38.3%), and Twitter (15.0%). Additionally, only a few (6.7%) had access to mobile applications for agriculture.

4.4 Utilization of digital tools and applications

Table 4 reveals the use of digital tools by rural farmers. The results showed that traditional digital broadcast media tools, including television (87.5%) and radio (84.2%), were still prominently used among the respondents. This aligns with the tools the farmers had access to. More than half

Table 3: Access to digital tools by rural farmers

Digital tools and applications	Have access Freq (%)	Do not have access Freq (%)
Smartphone	72 (60.0)	48 (40.0)
Computer/laptop	6 (5.0)	114 (95.0)
Radio	104 (86.7)	16 (13.3)
Television	106 (88.3)	14 (11.7)
WhatsApp	52 (43.3)	68 (56.7)
Facebook app	46 (38.3)	74 (61.7)
Google Chrome/web browser	45 (37.5)	75 (62.5)
Twitter app	18 (15.0)	102 (85.0)
Mobile apps for agriculture	8 (6.7)	112 (93.3)
Instagram app	10 (8.3)	110 (91.7)
Email apps and facilities	41 (34.2)	78 (65.8)

Source: Field Survey, 2021.

Table 4: Use of digital tools by rural farmers

Digital tools and applications	Use Freq (%)	Do not use Freq (%)
Smartphone	73 (60.8)	47 (39.2)
Computer/laptop	5 (4.2)	115 (95.8)
Radio	101 (84.2)	19 (15.8)
Television	105 (87.5)	15 (12.5)
WhatsApp	52 (43.3)	68 (56.7)
Facebook app	45 (37.5)	75 (62.5)
Google Chrome/web browser	34 (28.3)	86 (71.7)
Twitter app	9 (7.5)	111 (92.5)
Mobile apps for agriculture	7 (5.8)	113 (94.2)
Instagram app	6 (5.0)	114 (95.0)
Email apps and facilities	27 (22.5)	93 (77.5)

Source: Field Survey, 2021.

(60.8%) of the rural farmers also indicated that they use smartphones. It is worth noting that more than one-third of the rural farmers stated that they use WhatsApp (43.3%) and Facebook (37.5%), which are social media applications installed on their phones. This shows that some of the rural farmers in the area are already transitioning from the use of traditional digital media tools to using modern digital tools. However, overall, the level of transition is still rather slow, as most of the other modern digital tools and apps, such as Twitter, Instagram, and mobile apps for agriculture, are still mostly not used by most of the rural farmers in the area.

4.5 Purpose of use of digital tools by the farmers

Table 5 indicates that respondents in the study area prominently use digital tools they have access to mainly for communicating with other farmers and linkage with extension officers. Less than one-third of the farmers use digital tools

Table 5: Purpose of use of digital tools by rural farmers

Variables	Frequency	Percentage
Advertisements	28	23.3
Information access	31	25.8
Information sharing	31	25.8
Linking with extension agents	54	45.0
Communication with other farmers	55	45.8
Linking with agricultural inst.	24	20.0
Online banking	16	13.3
Online purchasing	3	2.5

Source: Field survey, 2021. NB: multiple responses.

for information access (25.8%), sharing (25.8%), and advertising (23.3%), while only a few of them use the tools and apps for online banking (13.3%) and purchases (2.5%). This result suggests that the majority of the respondents who have access to digital tools are not optimally utilizing these tools for various versatile purposes such as farm products marketing and sales, linkage with relevant agricultural institutions, and instant agricultural information access and sharing that these tools can be used for. This will also limit the benefits that their current usage of these tools can avail them.

4.6 Challenges to the usage of digital tools

Table 6 reveals the challenges that rural farmers face in relation to their usage of digital tools. Mean score ranking was used to rank the severity of the challenges as indicated by the respondents. The results showed that “Lack of Skills” (mean score = 1.24), “Lack of Training” (mean score = 1.12), “Cost of the tools” (mean score = 1.10), and “Network Coverage” (mean score = 1.05). These challenges were the prominent severe challenges faced by the respondents as they ranked 1st, 2nd, 3rd, and 4th, respectively.

4.7 Socio-economic factors influencing the utilization of digital tools and apps among farmers

Table 7 reveals the multiple linear regression results of the determinants of rural farmers’ use of digital tools. The

Table 6: Challenges faced by rural farmers when using digital tools

Challenges	Not severe	Moderately severe	Very severe	Mean score
Lack of skills	30 (25)	31 (25.8)	59 (49.2)	1.24
Cost of the tools	31 (25.8)	46 (38.3)	43 (35.8)	1.10
Cost of internet	50 (41.7)	46 (38.3)	24 (20)	0.78
Network coverage	20 (16.7)	74 (61.7)	26 (21.7)	1.05
Maintenance costs	39 (32.5)	52 (43.3)	29 (24.2)	0.92
Lack of training	30 (25)	46 (38.3)	44 (36.7)	1.12
Accuracy of information	50 (41.74)	48 (40)	22 (18.3)	0.77

Note: The value in parenthesis represents the percentages, while the values outside the parenthesis represent the frequencies.

Source: Field Survey, 2021.

Table 7: Socio-economic determinants of smallholder farmer utilization of digital tools

Variables	Coefficient (SE)	T	P
Location	-0.017 (0.075)	-0.23	0.817
Gender	-0.934 (0.648)	-1.44	0.152
Marital status	0.246 (0.683)	0.36	0.719
Household size	0.125 (0.162)	0.77	0.441
Educational level	1.653 (0.347)	4.77	0.000***
Farming experience	-0.024 (0.049)	-0.48	0.633
Secondary occupation	1.127 (0.666)	1.69	0.094*
Enterprise type	1.538 (0.539)	2.85	0.005***
Farm size	0.048 (0.116)	0.41	0.681
Farmer group	0.249 (0.720)	0.35	0.730
Extension agents visit	1.070 (0.781)	1.37	0.173
Visits to other locations	0.452 (0.209)	2.15	0.034**
F	6.01		
P	0.000		
R square	0.403		
Adjusted R square	0.336		

Note: Statistical significance *** $P < 0.01$, ** $P < 0.05$, * $P < 0.10$.

Source: Analysis of Field Survey, 2022.

model's adjusted R -squared was 0.336, and the F -test statistic was 6.01, with a statistical significance of $P < 0.01$. This indicates that the model fits well. The results show that the farmers' educational level and the type of enterprise they operate were significant at the 1 percent level of significance ($P \leq 0.01$) and positively influenced the farmers' use of digital tools. It was further noted that farmers' visits to other locations (cosmopolitaness) were significant at the 5 percent level of significance, while the variable of secondary occupation was significant at the 10 percent level and positively related to their use of digital tools. This evidence shows that these four socio-economic variables significantly determine the farmers' use of digital tools.

5 Discussion

The study was structured to include both traditional digital broadcast media and other modern digital tools, such as smartphones and apps embedded within them, to assess the level of transition among rural farmers in their use of these tools for information sourcing, sharing, and networking in an increasingly digitalized world. The findings from the study revealed that the farmers still had more access to "traditional" digital tools, like radio and television, than modern digital tools and apps. Further interactions with the farmers during data collection indicated that most of the farmers had access to digital radio platforms

via their phones, which were not necessarily smartphones. As a result, these traditional digital media tools were also the most prominently used tools among the farmers. Both radio and television continue to serve as important platforms for rural farmers to access information regarding weather forecasts, agricultural advice, market prices, and government policies. This aligns with the findings of Zwane [29], who reported that most smallholder farmers in South Africa depend on television and radio to receive and share agricultural information. Similarly, Oladele *et al.* [30] stated that many rural farmers in Kenya and Ethiopia indicated that television and radio are their preferred channels for sourcing information. These tools are also extensively used by extension agencies for mass communication to rural farmers in the global south [31]. The farmers in the area specifically mentioned finding digital media tools, such as radio and television, more useful because they reside in rural areas where internet access is limited and unreliable. This issue is further exacerbated by the load-shedding problems currently faced by South Africa, as the internet network is often affected during load-shedding periods. Furthermore, although modern digital tools and apps such as smartphones were used by more than half of the respondents, smartphone-embedded applications such as WhatsApp, Facebook, and Twitter were less prominently used for personal and agricultural purposes because the farmers also indicated a relatively low level of access to these tools. This is an interesting finding which indicates that farmers' access and use of smartphones does not directly indicate their use of modern digital applications that could be installed on these phones for various beneficial purposes such as information sourcing, transfer, networking, produce marketing, and communication with agricultural and rural advisory institutions are not being maximized. Even though Inegbedion *et al.* [32] opined that the contribution of mobile phones to the empowerment of farmers in the global south is increasingly becoming significant, farmers in this rural location in South Africa are still yet to take full advantage of the potential mobile smartphones and their embedded apps have to offer in improving their livelihoods. This will tend to limit the access of these farmers to timely and vital information that is increasingly being transmitted via these platforms globally, which might negatively affect their productivity, reduce their networking and marketing potential, and consequently reduce their farm income. The low level of use of these modern digital tools and apps among the study participants might be due to their age range, with the majority of them seen to be in their middle and old ages. In addition, the low level of education observed among the farmers and other constraining factors, which include inadequate knowledge and skills on the use of some of these modern tools and apps,

coupled with the cost and maintenance of some of these digital tools and apps, are some of the probable reasons why the transition of these rural farmers from using traditional digital broadcast media tools to increasingly using modern digitalized tools and apps seems slow. According to Cameron et al. [33], few rural farmers access information via digital tools because of a lack of knowledge and inadequate facilities in remote areas. Moreover, researchers [34,35] stated that the major constraints to the use of modern ICT among rural smallholder farmers were poor coverage, poverty and lack of resources, low knowledge, and literacy level of the farmers. Also, Coggins et al. [1] pointed out that commonly constraining factors affecting the optimal use of digital tools by farmers in Africa and Asia include devices and infrastructure inaccessibility, and digital. Looking at these findings through a comparative lens with other areas in the Global South, the low use of digital tools and the challenges reported in the study area align with trends observed in the region. According to Kudama et al. [36], the adoption rates of innovative digital tools among smallholder farmers in sub-Saharan Africa remain low due to factors such as digital illiteracy, affordability, and, in some cases, gender disparities. Moreover, the results from the regression analysis point out that farmers with higher educational attainment, and who are more cosmopolitan, have a higher likelihood to use digital tools for agricultural purposes than their counterparts who are not. According to previous studies [11,37], cosmopolitan individuals tend to be more exposed, interested in trends and happenings outside their location and thus more innovative. This usually enhances technology adoption and utilization than less cosmopolitan individuals. Also, Saint-Macary et al. [38] stated that a higher level of education increases farmers' knowledge of the potential benefits of adopting technology and digital tools in agriculture, which is expected to translate to an increased level of utilization.

6 Conclusion and recommendations

Based on the study's findings, it concludes that the majority of rural farmers have access to and use traditional digital media tools such as television and radio. Additionally, over half of them have smartphones, but their usage of modern digital tools and apps embedded on these devices, like WhatsApp, Facebook, Twitter, and other mobile apps, is still low overall, both for personal and agricultural purposes. This highlights to the global agri-food community

that rural farmers having smartphones does not necessarily mean they are optimizing them for various beneficial purposes related to their livelihoods. The limited use of modern digital tools by study participants will hinder their ability to fully leverage the potential benefits of timely information sharing and access, increased networking and marketing opportunities, and stakeholder linkages in agri-food systems that modern tools offer. Furthermore, the low usage of modern digital tools among respondents is attributed to a few key challenges, including inadequate skills and training opportunities, high costs of tools and apps, and issues related to network coverage. The education level of rural farmers and their level of cosmopolitanism were also found to be significant socio-economic factors influencing the usage of modern digital tools. In light of this, policy measures aimed at improving digital agriculture in the area should prioritize the enhancement of rural adult education through extension education and advisory services, as this variable is a key influencer of rural farmers' usage of modern digital tools. Extension agencies should also facilitate training sessions for farmers to optimize the use of modern digital tools and apps. These sessions should cover available farm management and weather monitoring apps, as well as the use of social media for marketing farm produce. Additionally, rural farmers should receive training on how to use their smartphones to access remote advisory services and facilitate financial transactions. It is also essential to enhance their digital literacy, enabling them to recognize and protect themselves from scams when using these digital tools. Equipping farmers with these necessary skills will allow them to explore and utilize these tools effectively and efficiently for the benefit of their agricultural enterprises. Furthermore, the government should provide farmer-friendly credit schemes, subsidy initiatives, and invest in adaptable digital technology for rural farmers to reduce the financial burden of using and maintaining modern digital tools and apps. This will encourage more farmers to transition from traditional digital broadcast media tools to smartphones and their various embedded apps. Such government schemes and policies will enhance inclusivity and ensure financial and technical sustainability in accessing and using these digital tools by rural farmers. Moreover, as part of strategies that have proven instrumental in overcoming some of these challenges in other parts of the world, policy initiatives and technological research efforts aimed at developing relevant and context-specific digital apps that align with the specific needs of farmers need to be encouraged to enhance the adoption of digital tools among farmers in rural areas. Finally, internet and network providers should upgrade their coverage and capacity in rural areas of South Africa to address the issue of inadequate

network coverage experienced by users in such areas. As part of a broader rural development strategy to improve digital access, the government can explore partnerships with satellite providers to deliver affordable and reliable satellite-based internet services to rural areas that have limited or no terrestrial network infrastructure.

Despite the promising results of this study, it is important to acknowledge that, like other research studies, this article has limitations. The study was restricted by a smaller sample size than initially expected. Although efforts were made to recruit more participants, logistical constraints related to time and limited availability of participants due to skepticism and physical contact concerns during the transition period of the COVID-19 pandemic resulted in fewer study participants than planned. This may introduce bias, as certain segments of the target population may not have been adequately represented, reducing the generalizability of the study's results. However, the study attempted to mitigate bias by using a purposive sampling strategy to ensure representation of different demographic groups within the available sample, thus reducing bias in the study. Additionally, the study employed techniques to ensure the accuracy of responses by posing questions in multiple ways to capture the necessary information, thereby controlling sample response error. These efforts make the insights from the study valuable to stakeholders in the agri-food systems and contribute to the knowledge of digitalized agriculture transition and use among rural farmers in the global south. Based on the outcomes of this study, future research could explore the specific use of individual digital applications and expand to include other, more innovative digital tools, such as weather monitoring platforms and farm management apps, while also examining their empirical effects on farmers' productivity and livelihoods. Moreover, future studies in the same area would benefit from a larger and more representative sample size and a diverse sampling methodology to enhance the generalizability of the findings.

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